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TRAFFIC CONTROL USING FUZZY LOGIC

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ABSTRACT

Fuzzy Logic is based on distinguish between Binary variable which is present in Classical sets which are restricted. Fuzzy Logic helps us to build linguistic variable which enables us to create minute differences in any application. This paper covers the basics of Fuzzy logic. The entire concept of fuzzy logic is presented in well-defined manner. When to use and how to use fuzzy logic is explained.There are many application in which fuzzy logic is used and I have implemented one of them. I have demonstrated a C++ code with algorithm to detect the traffic flow on roads and I have discuss its results. Future scope with the extension of existing code would be helpful.

KEYWORDS: Fuzzy Logic, Traffic, Traffic Management

INTRODUCTION TO FUZZY LOGIC

In a classical set the value of function is known from membership and non-membership function. Also this set is well defined and constrained. For an element in a universe that contains fuzzy sets, this transition can be gradual. This transition among various degrees of membership can be thought of as conforming to the fact that the boundaries of the fuzzy sets are vague and ambiguous. Hence, membership of an element from the universe in this set is measured by a function that attempts to describe vagueness and ambiguity.[1]

A fuzzy set, then, is a set containing elements that have varying degrees of membership in the set. This idea is in contrast with classical, or crisp, sets because members of a crisp set would not be members unless their membership is full, or complete.[1]

History of Fuzzy Logic

Fuzzy Logic is derived due to uncertainty. From Historical point of view many data sets were having uncertainty in them and results are ambiguous. In the traditional view of science, uncertainty represents an undesirable state, a state that must be avoided at all costs. This was the state of science until the late nineteenth century when physicists realized that Newtonian mechanics did not address problems at the molecular level. Newer methods, associated with statistical mechanics, were developed, which recognized that statistical averages could replace the specific manifestations of microscopic entities.

The gradual evolution of the expression of uncertainty using probability theory was challenged, first in 1937 by Max Black, with his studies in vagueness, then with the introduction of fuzzy sets by Zadeh (1965). Zadeh's paper had a profound influence on the thinking about uncertainty because it challenged not only probability theory as the sole representation for uncertainty but also the very foundations upon which probability theory was based: classical binary (two-valued) logic (Klir and Yuan, 1995).[1]

Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false.

Why Fuzzy Logic?

Following Reasons satisfy the need to use Fuzzy Logic.

- Fuzzy logic is conceptually easy to understand.
- Fuzzy logic is flexible.
- Fuzzy logic is tolerant of imprecise data.
- Fuzzy logic can model nonlinear functions of arbitrary complexity.
- Fuzzy logic can be built on top of the experience of experts.
- Fuzzy logic can be blended with conventional control techniques.

In following case we must not use fuzzy Logic.

- Codification is easy.
- Learning Fuzzy logic is taking time.
- Simple input and output system.
- If a simpler solution already exists

Fuzzy Control System

Like every system Fuzzy Logic also has a Control System from where it takes input uses fuzzy inference and give output. The diagram of fuzzy controller is shown in figure 1.

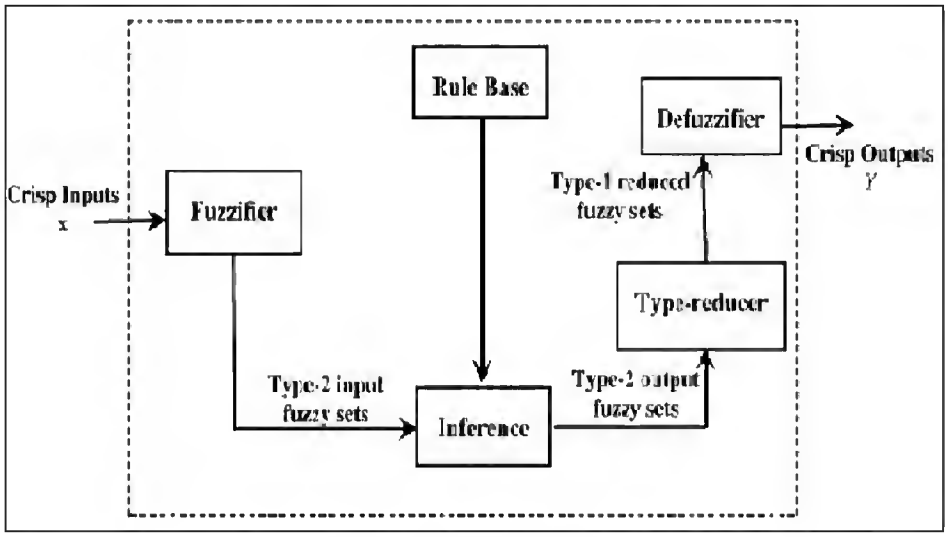

Figure 1: Fuzzy Controller

In this first chapter we have seen the concept of Fuzzy Logic and its Control System. In further chapters we will try to find application which uses fuzzy logic and will also try to simulate and implement one of them.

BASIC FUZZY LOGIC APPLICATION

Student Evaluation

Students‟ evaluation if not done properly it will affect their present and future opportunities. It is necessary that students‟ evaluation should be done in more fair and transparent manner. Reforms in education systems are necessary not just in curriculum but also in students‟ evaluation process. Content of curriculum are updated on regular basis. Recent technology is added as a part of curriculum so that students should get up-to-date knowledge about the new technologies. Education reforms should be significant as a part of educational policies. With the vision of education reforms we keep on updating our curriculum but there is less concerns about how to provide a fair and appropriate evaluation method to students. Evaluation system should be regularly reviewed and improved and should be fair and beneficial to all students.[2]

There are various type of teachers categorized as Strict, Normal, Lenient. The marks given by different teachers are different but by this the score of student must not be affected for this we use fuzzy logic and we create a fuzzy inference by repeated training so that the system can help us to get the correct score of student.

Washing Machine

Fuzzy Logic can be found in many home appliances such as rice cooker, vaccum cleaner and washing machine. The working of fuzzy logic in washing machine is shown below:

First it always takes a base of 10 minutes. It does this so that people are happy with its work even if they put completely clean laundry in to wash. It then calculates to what degree it is dirty. If it is 100% dirty it adds two minutes per piece of laundry. Of course a real washing machine would just do these calculations in the end, but our model does it for each individual piece so you can keep track of what is going on easier.[8]

So if you now add a piece which is only 50% dirty, it will add 50% of 2 minutes; it adds 1 minute instead of 2 minutes to the base of 10 minutes.[8]

These are only two aspects a fuzzy washing machine might take into account when washing. A real one would also check to see how much soap it needs, how much water to add, how fast and which direction it should spin, etc. If we wanted to graph every calculation a fuzzy machine makes, we would need a pretty complex hypercube. So we'll just limit ourselves to grease and dirt.[8]

Driving Application

Fuzzy Logic is used in driving application for automatic driving and automatic brake.many traffic situations remain complex and difficult to manage, particularly in urban settings. The driving task belongs to a class of problems that depend on underlying systems for logical reasoning and dealing with uncertainty. So, to move vehicle computers beyond monitoring and into tasks related to environment perception or driving, we must integrate aspects of human intelligence and behaviors so that vehicles can manage driving actuators in a way similar to humans. This is the motivation behind the AUTOPIA program, a set of national research projects in Spain. [9]

Overtaking

The system can also manage obstacles orother vehicles in the vehicle’s path by calculating when the vehicle should change lanesto overtake the (mobile or immobile) obstacle. First,

- The vehicle must be in the straight-lane driving mode,
- The left lane must be free, and
- There must be room for the overtaking.

Given this, overtaking occurs as follows:[9]

- Initially, the vehicle is in straight-lane mode.
- The driving mode changes to lane change mode, and the vehicle moves into the left lane.
- The driving mode changes to straight lane mode until the vehicle has passed the obstacle or vehicle.
- The driving mode again changes to lane-change mode, and the vehicle returns to the right lane.

Figure 2: To Overtake a Car

Traffic Control Using Fuzzy Logic

Problem

Traffic congestion problems are commonly encountered in our daily life. Congestion may occur due to various conditions such as inadequate number of lanes, rough road surface and poor road visibility. The consequences of traffic congestion are known to be rather expensive.[4]

Factors Useful in Algorithm

- No. of lanes
- Quality of Road
- Visibility

No. of Lanes

A road where tendency of traffic volume is large should contain more number of lanes, which will help the flow of traffic and will negate congestion. Number of lanes, as fuzzy input is provided by three fuzzy sets. These are minimum number of lanes, average number of lanes and maximum number of lanes. In the proposed method we limit the maximum number of lanes up to five. A road containing only one lane is considered as minimum number of lane road a road containing two or three lanes is considered as average number of lane road. Similarly a road containing four or five lanes is considered as maximum number of lane road.[4]

Quality of Road

Road surface depicts the condition of road. There are chances of a road being in a bad condition even if it contains

maximum number of lanes. For good road condition the surface of road should be smooth and not spoiled. Rough and uneven roads are always subject to traffic congestion, and ill traffic flow. For better traffic flow, the surface of roads must be smooth. Our fuzzy inference system is considering road surface as an input variable. It can be rough, average and smooth and these considered as fuzzy sets of this fuzzy input.[4]

Visibility

The visibility factor is considered only in night mode because at day time, visibility of a road is considered as always good. In night mode the visibility is very effective for flow maintenance. Visibility in context of this study is the level of a visibility of a certain road in night mode over a period of time (months, years) not a particular day. Clouds, dust etc come into play only in a system which is on a daily basis. Traffic flow can be affected in case of poor condition of light on a road. The visibility of a road can be improved by providing extra light poles at roads. The determination of threshold capacity is based on visibility only in evening, night and morning. To implement the factor of visibility we have split it into three fuzzy sets which are poor visibility, average visibility and good visibility.[4]

PROPOSED ALGORITHM TO CONTROL TRAFFIC USING FUZZY LOGIC

ADVISORY_ALGO (u,v,OptimalCapacity,Tendency of Flow, Changed optimal capacity)

Q=empty

ParentQ = empty

Diff (u,v) = Changed optimal capacity(u,v) – Optimal Capacity(u,v)

Set threshold

Set color all junctions to write

Color {ul = black

Push v in Q

Push u in ParentQ

While Q is not empty and diff > threshold

Pop V from Q

Pop u from ParentQ

For each adjacent junction w of v

If color [w) = white

Diff (v,w) = Diff(u,v) * (Tendency of Flow (u,v,w) /100)

Current Flow (v,w) = Current Flow (v.w) + diff(v .w)

Pushwin Q

Push v in ParentQ

Color[v) = black

Code to Control Traffic Using Fuzzy Logic

The C++ Code to Detect the Traffic on road is as follows:

Input: No.of lanes, Road Surface, Visibility. *Output*: µmin, µavg, µmax.

```
#include <iostream>
Using namespace std;
int main() {
floatroadSur, nLanes, visibility;
cout<<"Enter the value for number of lanes "<<endl; cin>>nLanes;
cout<<"Entre the value for Road surface "<<endl;      cin>>roadSur;
cout<<"Enter value for visibility "<<endl;
cin>>visibility;
floatmuRoad[3] = {0}, muLanes[3] = {0}, muVisibility[3] = {0};
if (nLanes<=1) { muLanes[0] = 1;
}
else if(nLanes<= 2.5) {muLanes[0] = (2.5 - nLanes)/1.5;
}
if(nLanes<=3) {muLanes[1] = (nLanes - 1)/2;
}
else if(nLanes>= 3 &&nLanes<=5){muLanes[1] = (5-nLanes)/2;
}
if(nLanes>= 3 &&nLanes<=5) {muLanes[2] = (nLanes - 3)/2;
}
else if(nLanes> 5) {muLanes[2] = 1;
}
if(roadSur<=0.5) {muRoad[0] = 1;
}
else if(roadSur<= 1) {muRoad[0] = 2 * (1 - roadSur);
}
if(roadSur<= 0.5) {muRoad[1] = 2 * (0.5 - roadSur);
```

```
        }
        else if(roadSur<= 1){muRoad[1] = 2*(1-roadSur);
        }
        if(roadSur<=0.5) {muRoad[2] = 2 * roadSur;
        }
        else if(roadSur> 0.5) {muRoad[2] = 1;
        }
        if(visibility<=0.5) {muVisibility[0] = 1;
        }
        else if(visibility <= 1) {muVisibility[0] = 2 * (1 - roadSur);
        }
        if(visibility <= 0.5) {muVisibility[1] = 2 * (0.5 - visibility);
        }
        else if(visibility <= 1){muVisibility[1] = 2*(1-visibility);
        }
        if(visibility <=0.5) {muVisibility[2] = 2 * visibility;
        }
        else if(visibility > 0.5) {muVisibility[2] = 1;
        }
        cout<<"Lanes : "<<endl;   cout<<"MUmin\tMUavg\tMUmax"<<endl;
        cout<<muLanes[0]<<"\t"<<muLanes[1]<<"\t"<<muLanes[2]<<endl;
        cout<<"Road Surface : "<<endl;     cout<<"MUmin\tMUavg\tMUmax"<<endl;
        cout<<muRoad[0]<<"\t"<<muRoad[1]<<"\t"<<muRoad[2]<<endl;
        cout<<"Visibility : "<<endl;          cout<<"MUmin\tMUavg\tMUmax"<<endl;
        cout<<muVisibility[0]<<"\t"<<muVisibility[1]<<"\t"<<muVisibility[2]<<endl;
}
```

RESULTS

The Traffic on the basis of no. of lanes, road surface and visibility is found and this is provided as input to neural network to control the traffic.

CONCLUSIONS

Fuzzy Logic can be used in detection of traffic under various condition. Fuzzy logic provides a optimal solution to traffic problem because it distinguish between the various membership function. The output is provided to neural network circuit where many such cases are given to neural circuit based on which it provide a optimal solution.

FUTURE SCOPE

Fuzzy Logic further can be used with sensors in many area where human can't reach to take decision based on inferences given to it. Further in Traffic management it can be used to detect the sign on sign board to take decisions[7]. Also in automatic braking system we can use fuzzy logic.[5]

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